A Case for Telestroke in Military Medicine: A Retrospective Analysis of Stroke Cost and Outcomes in U.S. Military Health-Care System

Ajal Dave, MD,* Kendra Cagniart, MD,* and Matthew D. Holtkamp, DO†

Background: The development of primary stroke centers has improved outcomes for stroke patients. Telestroke networks have expanded the reach of stroke experts to underserved, geographically remote areas. This study illustrates the outcome and cost differences between neurology and primary care ischemic stroke admissions to demonstrate a need for telestroke networks within the Military Health System (MHS). *Materials and Methods:* All adult admissions with a primary diagnosis of ischemic stroke in the MHS Military Mart database from calendar years 2010 to 2015 were reviewed. Neurology, primary care, and intensive care unit (ICU) admissions were compared across primary outcomes of (1) disposition status and (2) intravenous tissue plasminogen activator administration and for secondary outcomes of (1) total cost of hospitalization and (2) length of stay (LOS). *Results:* A total of 3623 admissions met the study's parameters. The composition was neurology 462 (12.8%), primary care 2324 (64.1%), ICU 677 (18.7%), and other/unknown 160 (4.4%). Almost all neurology admissions (97%) were at the 3 neurology training programs, whereas a strong majority of primary care admissions (80%) were at hospitals without a neurology admitting service. Hospitals without a neurology admitting service had more discharges to rehabilitation facilities and higher rates of in-hospital mortality. LOS was also longer in primary care admissions. *Conclusions:* Ischemic stroke admissions to neurology had better outcomes and decreased LOS when compared to primary care within the MHS. This demonstrates a possible gap in care. Implementation of a hub and spoke telestroke model is a potential solution. **Key Words:** Mortality/survival—quality and outcomes—stroke—CVA—neurology—telestroke.
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All authors have read and approved the submitted manuscript; the manuscript has not been submitted elsewhere nor published elsewhere in whole or in part.Address correspondence to Matthew D. Holtkamp, DO, Carl R. Darnall Army Medical Center, 58th Street, Bldg. 36029, Fort Hood, TX 76544. E-mail: Matthew.d.holtkamp.mil@mail.mil.

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Introduction

One of the leading causes of death and disability worldwide is stroke.[1,2] The American Heart Association and other international organizations have published evidence-based guidelines recommending that these patients receive care in specialized stroke care units. These settings provide treatments that decrease morbidity and mortality.[3-6] Specialized care is required, including clinicians with expertise in caring for stroke victims. Rapid access to brain and vascular imaging is vital. There is wide variation in access to this care.[7-10] Multiple studies have shown that stroke centers reduce death and disability from stroke.[11-15] There is a growing body of evidence that telestroke networks decrease thrombolytic time and improve outcomes similar to primary stroke centers.[16-19] This retrospective study demonstrates the difference in ischemic stroke outcomes between neurology and primary care admissions. The gap in care found with this study can be resolved by the implementation of a telestroke hub and spoke model within the Military Health System (MHS).

The MHS is a single-payer system where everyone has the same coverage/insurance.[20] The MHS has 9.4 million beneficiaries, more than 350 health-care clinics, and 55 military hospitals around the world. These cover active duty service members, their dependents, and retirees. Every year, the MHS has an average of 1 million hospital admissions and provides 128 million prescriptions for medication.[21] The MHS system has a wide variety of hospitals and medical specialties. It operates 3 neurology residency training programs but no primary stroke centers.[22] The U.S. Army Medical Department is the largest of all military services medical departments and is divided into regional health commands, 3 of which are within the continental United States. There is at least 1 large academic teaching institution within each command.[23] Because the MHS is a closed single-payer system and has at least 1 large academic teaching institution within each regional command, a hub and spoke telestroke model could be an ideal fit.

In our study, we demonstrate the outcome differences in ischemic stroke admissions between neurology admitting services at large (hub) hospitals and primary care admitting services at other hospitals. These outcomes show the need for a telestroke network. Such a network enables the expertise of a stroke specialist to be broadly delivered to smaller rural, geographically remote hospitals. This study evaluated 3 admitting services: neurology, primary care, and intensive care unit (ICU). Evaluation was on primary outcomes: (1) discharge to a rehabilitation facility or in-hospital mortality, (2) in-hospital mortality alone, and (3) intravenous tissue plasminogen activator (IV tPA) administration. Comparison was also made for secondary outcomes: (1) total cost of the hospitalization and (2) length of stay (LOS). Two of the 5 (in-hospital mortality and LOS) are outcomes addressed in the Affordable Care Act[24] and by the Centers for Medicare and Medicaid Services as quality indicators.[25]

Materials and Methods

Data were obtained from the MHS Military Mart (M2) administrative database between 2010 and 2015. The M2 database tracks all admissions (inpatient and outpatient) to military treatment facilities (MTFs). The MHS M2 database has the capacity to document up to 20 diagnoses and 20 procedures for each hospital admission. The primary diagnosis is the first listed for the hospital admission. All admissions with a primary diagnosis of ischemic stroke were included in the study. The following International Classification of Diseases, ninth edition (ICD-9) codes were used to identify ischemic strokes: 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434, 434.01, 434.1, 434.10, 434.9, 434.90, 434.91, 436, and 434.11. Stroke comorbidities were identified using the ICD-9 codes for hypertension (401-405), diabetes mellitus (249-250.XX) and atrial fibrillation (427.31, 427.32). The authors recognize other known comorbidities may also be important, for example dyslipidemia, heart failure, and coronary disease. Unfortunately, coding for these was sparse. They were omitted, as the data were deemed unreliable. Admission demographic information of military rank (as a possible social economic status surrogate), race, marital status, sex, and age were identified along with hospital size (small, medium, or large). Other information that was gathered included primary admitting service, time of admission, and use of IV tPA (ICD-9 procedure code 99.10) and disposition status (home, nursing facility, or in-hospital mortality). National Institutes of Health Stroke Score was not available within the M2 administrative database and all data were deidentified, making chart review difficult. This information would have been a useful measure of initial stroke severity.

Admitting service was our primary variable of interest. The study groups were (1) neurology, (2) primary care (internal medicine and family medicine), and (3) ICU. Neurology admitting services are present at the 3 large neurology training programs. This group was set as the standard of care for ischemic stroke admissions within the MHS. Almost all (97%) of neurology admissions were at these 3 hospitals. Primary care was chosen as the surrogate for areas without a neurology admitting service. A majority of primary care admissions (80%) were at hospitals without a neurology admitting service. ICU admissions were used to remove the sickest admissions from both the neurology and primary care groups. Because of possible confounding bias between size of hospital and admitting service (neurology and ICU admitting services are only present at large MTFs), hospital size was split into large versus medium/small hospitals and was controlled. The M2 database uses peer grouping by

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